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**(54) [Title of Invention] Device for Electron Beam Sterilization of Empty Plastic Containers**

**(57) [Abstract]**

**[Problem to Be Solved by the Invention]**

To provide a device for electron beam sterilization of empty plastic containers which can sterilize empty plastic containers at high speeds (for example 300 or more containers per minute) without being influenced by the shape of the container, whether round or angular, while the empty plastic container which is used for soft drinks and the like is in an upright position which is the normal state in which the containers are conveyed without tipping them on their side, using low voltage and low dosage electron beams.

**[Means Used to Solve the Problem]**

The invention is provided with (1) a rotating mechanism 3 which vacuum-suctions an empty plastic container P which is supplied from a supply mechanism 2 and fixes it and at the same time rotates the empty plastic container in its fixed state; (2) an electron beam irradiation mechanism 4 which irradiates electron beams onto the empty plastic container P which is rotated; and (3) an interval retaining mechanism 5 which is capable of retaining at a constant interval the interval D between the electron beam irradiation mechanism 4 and the empty plastic container P.



**[Claims]**

**[Claim 1]** A device for electron beam sterilization of empty plastic containers which carries out sterilization by irradiating electron beams on an empty plastic container, the invention characterized as being provided with:

- (1) a supply mechanism which supplies the aforementioned empty plastic container;
- (2) a rotating mechanism which vacuum-suctions the empty plastic container which has been supplied and fixes it and at the same time rotates said empty plastic container in its fixed state;
- (3) an electron beam irradiation mechanism which irradiates the aforementioned electron beams onto the aforementioned empty plastic container which is being rotated;
- (4) an interval retaining mechanism which is capable of retaining at a constant interval the interval between this electron beam irradiation mechanism and the aforementioned empty plastic container; and
- (5) an ejection mechanism which ejects the aforementioned empty plastic container which has been irradiated with the electron beams;

**[Claim 2]** The device according to claim 1 wherein the aforementioned rotating mechanism rotates the aforementioned empty plastic container so that it autorotates;

**[Claim 3]** The device according to claim 1 wherein the aforementioned electron beam irradiation mechanism is provided with multiple electron beam irradiation parts which are disposed on its periphery;

**[Claim 4]** The device according to claim 1 wherein the aforementioned electron beam irradiation mechanism is synchronized so that it rotates at the same rotation speed as the aforementioned empty plastic container;

**[Claim 5]** The device according to claim 1 wherein the aforementioned interval retaining mechanism is provided with: (1) a pinion gear which is shaped to fit the sectional form of the aforementioned empty plastic container; and (2) a gear which rotates so that it can interlock with this pinion gear.

#### **[Detailed Description of the Invention]**

##### **[0001]**

**[Technical Background of the Invention]** The present invention relates to a device for electron beam sterilization of empty plastic containers and particularly to a device for electron beam sterilization of empty plastic containers which sterilizes by irradiating electron beams onto so-called PET [polyethylene terephthalate] bottles and other empty plastic containers used for soft drinks and the like.

##### **[0002]**

**[Description of the Prior Art]** An example of the prior-art devices used to sterilize empty plastic containers is the device mentioned in Japan Unexamined Patent Publication No. H8[1996]-169,422 wherein the transmission power of the electron beams is weak since it involves irradiation of low-voltage electron beams (200 to 250 KV). After the empty plastic

container has been turned over sideways while it is being rotated, the electron beams are irradiated from the side in close proximity to it.

[0003] As a result, since electron beam irradiation was carried out while the empty plastic container was being rotated, there were problems in that it could only be applied for empty containers which were round. There were also problems in that sterilization could not be carried out at high speeds since rotation had to be carried out using a rotation roller without fixing [in place] the round bottle. Specifically, the maximum [sterilization] speed was approximately 70 bottles per minute.

[0004] There were also problems in that the empty plastic container was usually placed upright while it was being conveyed and filled. It was turned on its side once for sterilization processing and then had to be placed upright a second time after sterilization. This required separate mechanisms for turning the container on its side and then standing it upright, thus requiring a complex conveying mechanism.

[0005]

**[Problems Which the Present Invention Is Intended to Solve]** It is an object of the present invention to take into consideration the aforementioned problems and to provide a device for electron beam sterilization of empty plastic containers which are used for soft drinks and the like which can carry out in-line sterilization using electron beams.

[0006] It is another object of the present invention to provide a device for electron beam sterilization of empty plastic containers which can carry out high speed (for example 300 or more bottles per minute) sterilization of empty plastic containers using low-voltage and low-dosage electron beams.

[0007] It is yet another object of the present invention to provide a device for electron beam sterilization of empty plastic containers which can carry out sterilization while [the empty container] is upright which is the usual conveying state without turning the empty plastic container sideways.

[0008] It is still another object of the present invention to provide a device for electron beam sterilization of empty plastic containers which can carry out the sterilization process regardless of the shape of the containers, be they round, angular or the like.

[0009]

**[Means Used to Solve these Problems]** Thus, it is an object of the present invention to provide a device for electron beam sterilization of empty plastic containers which can (1) vacuum-suction empty plastic containers, fix them while they are upright and rotate them so that an electron accelerator can accordingly irradiate electron beams onto the empty plastic container while it rotates; (2) rotate the empty plastic container using a turntable and the like, synchronize the irradiation with the turntable and drive the electron beam accelerator; and (3) retain the empty plastic container using the aforementioned vacuum suctioning process and at the same time use a pinion gear which is shaped like the empty plastic container; so that sterilization can

be carried out by irradiating electron beams onto the empty plastic container. The device is provided with (1) a supply mechanism which supplies the aforementioned empty plastic container; (2) a rotating mechanism which vacuum suctions the empty plastic container which has been supplied and fixes it and at the same time rotates said empty plastic container while in its fixed state; (3) an electron beam irradiation mechanism which irradiates the aforementioned electron beams onto the aforementioned empty plastic container which is rotating; (4) an “interval” retaining mechanism which can retain at a constant interval the interval between this electron beam irradiation mechanism and the aforementioned empty plastic container; and (5) an ejection mechanism which ejects the aforementioned empty plastic container which has already been irradiated with electron beams.

**[0010]** The aforementioned rotation mechanism makes it possible to rotate the aforementioned empty plastic container and have it autorotate at the same time.

**[0011]** The aforementioned electron beam irradiation mechanism can be provided with multiple electron beam irradiation parts which are disposed on the periphery of the mechanism.

**[0012]** The aforementioned electron beam irradiation mechanism can rotate so that it is synchronized with the rotation speed of the aforementioned empty plastic container.

**[0013]** The aforementioned interval retaining mechanism may be provided with a pinion gear which is shaped to fit the sectional form of the aforementioned empty plastic container and a gear which rotates so that it can interlock with this pinion gear.

**[0014]** In the device used for electron beam sterilization of empty plastic containers in the present invention, the empty plastic container is vacuum suctioned by the rotation mechanism. It is fixed and rotated in the fixed state and electron beams are irradiated onto the empty plastic container using an electron beam irradiation mechanism. Thus, the empty plastic container can be rotated while it is in an upright position without turning it on its side. Electron beams are irradiated between these rotations thus making it possible to carry out sterilization at high speeds.

**[0015]** The device also retains at a constant interval the interval between the electron beam irradiation mechanism and the empty plastic container using the interval retaining mechanism. As a result, it can irradiate electron beams at a distance which is close enough to sterilize the containers even with low-dosage electron beams and at the same time can sterilize efficiently empty plastic containers of any shape, be they round or angular.

**[0016]**

**[Practical Embodiment of the Invention]** Next we shall describe the electron beam sterilization device used for sterilizing empty plastic containers based on a practical embodiment of the present invention based on Figure 1 through Figure 4. Figure 1 is a schematic plane view of the electron beam sterilization device 1 used to sterilize the empty plastic containers. The electron beam sterilization device 1 for empty plastic containers is provided with (1) a supply mechanism 2 which supplies the empty plastic container P; (2) a rotation mechanism 3; (3) an electron beam irradiation mechanism 4; (4) an interval retaining mechanism 5 (see in particular Figure 2 and

Figure 3); and (5) an ejection mechanism 6 which ejects the empty plastic container P which has already been irradiated with electron beams.

[0017] The empty plastic container P is an empty plastic container such as a so-called PET [polyethylene terephthalate] bottle used for soft drinks and other round or square containers of any shape which can be penetrated by electron beams.

[0018] The supply mechanism 2 supplies the empty plastic container P while it is upright in a line using any type of conveyer. As a result, the empty plastic containers P are loaded onto the rotation mechanism 3 one by one with a predetermined interval between them using a star wheel 7 on the boundary with the rotation mechanism 3.

[0019] Figure 2 is a sectional lateral view of the main parts of the device 1 used for electron beam sterilization of empty plastic containers, in particular, the rotation mechanism 3, the electron beam irradiation mechanism 4 and the interval retaining mechanism 5. The rotation mechanism 3 vacuum suctions and fixes the empty plastic container P which has been supplied from the supply mechanism 2. At the same time it rotates the empty plastic container while it is in a fixed state so that it autorotates. It is provided with a turntable drive part 10 which itself is provided with a motor 8 and a reduction gear 9, a turntable drive shaft 11 and multiple (eight in the example illustrated) turntables 12 used for fixing the empty plastic containers. The empty plastic containers P which are supplied from the supply mechanism 2 are loaded one by one onto the turntable 12 used for fixing the empty plastic containers, where they are fixed and retained.

[0020] The turntable 12 disposes these at a uniform predetermined interval on the rotation trajectory 13. At the same time vacuum exhaust is carried out from the vacuum suction inlet 14 which is formed on this as an opening. As a result, the empty plastic container P is vacuum suctioned, fixed and retained on the bottom part of this. Further, a vacuum hose 15 on the vacuum suction part 14 connects this to the turntable drive shaft 11 via a first rotary joint 16.

[0021] Further, the turntable 12 connects this to the turntable drive shaft 11 via the pinion gear 23, the coupling piece 24 and the air cylinder 22 on the interval retaining mechanism 5 which will be described further on. As a result, while the bottom of the empty plastic container P is vacuum suctioned and fixed on the vacuum suctioning opening 14, the periphery of the container can be rotated at a predetermined rotation speed as the turntable 12 turns while the interval between the containers is maintained at a constant.

[0022] The electron beam irradiation mechanism 4, synchronized with the rotation mechanism 3, irradiates electron beams all around the inside of the empty plastic container and sterilizes it. This mechanism is provided with (1) a radial arm 18 which is attached in radial fashion via the second rotary joint 17 on the turntable shaft 11; and (2) an electron beam irradiation part 19 which is made up of an electron beam accelerator and the like which is attached to the front end part of this radial arm 18.

[0023] There are as many electron beam irradiation parts 19 (eight in the example given in the figure) as there are turntables 12 on the rotation trajectory 13 of the rotation mechanism. As indicated in Figure 1 in particular, a single electron beam irradiation part 19 corresponds to a

single empty plastic container P. At the same time, the electron beam irradiation part 19 also rotates so that it is synchronized with the rotation speed of the empty plastic container P in the rotation mechanism 3. Thus, the electron beam irradiation mechanism 4 is positioned inside the turntable 12 of the rotation mechanism 3. The electron beam irradiation part 19 faces the empty plastic container P from the inside periphery of the turntable 12. It can irradiate, for example, low-voltage electron beams of 200 to 250 KV and can carry out sterilization by sufficiently transmitting and irradiating the beams so that they reach the other side of the empty plastic container P.

**[0024]** The interval retaining mechanism 5 retains at a constant interval the interval between the electron beam irradiation mechanism 4 (electron beam irradiation part 19) and the empty plastic container P. As a result, it is provided with (1) a pair of upward and downward ring-shaped gears which are fixed and attached to the turntable drive shaft 11; (2) an air cylinder 22 which is attached to the turntable drive shaft 11 via a third rotary joint 21; (3) a pair of upward and downward pinion gears 23 which interlock respectively with the outside circular parts of the pair of upward and downward gears 20; and (4) a coupling piece 24 which couples the pair of upward and downward pinion gears 23.

**[0025]** Figure 3 is a plane view of the important parts of the interval retaining mechanism 5. The air cylinder 22 always energizes the pinion gear 23 by a predetermined energizing force in the direction of the gear 20. When gear part 20A of the gear 20 and gear part 23A of the pinion gear 23 interlock, the empty plastic container P which is fixed thereto revolves (arrow 25 indicating revolution) along the rotation trajectory 13 of the turntable 12 as it rotates and at the

same time it can autorotate (arrow 26 indicating autorotation). This means that the gear 20 ensures the rotation trajectory 13 of the pinion gear 23.

[0026] The pair of upward and downward pinion gears 23 may have any shape as long as they are flat. In the example illustrated in Figure 3, they are shaped to fit the sectional form of the empty plastic container P so that the interval between the rectangular—in profile (angular)—empty plastic container P and the electron beam irradiation part 19 of the electron beam irradiation mechanism 4 is constant.

[0027] Figure 4 is a plane view of the interval retaining function carried out by the interval retaining mechanism 5. It is regulated by the interlocking of the gear 20 and the pinion gear 23 even when autorotation is accompanied by the revolution of the empty plastic container P. This indicates that the interval D between the surface of the empty plastic container P and the front end part 19A of the electron beam irradiation part 19 is always maintained at a constant.

[0028] The ejection mechanism 6 is used to eject the empty plastic container P which has already been irradiated with electron beams so that it conveys the empty plastic container P to the next post-processing step using any type of conveyor in the same way as the supply mechanism 2. In the post-processing step, the empty plastic container P which has already been sterilized is sent along so that it is free of any bacteria and it is filled with the contents using a filling device and the like.

[0029] In the device for electron beam sterilization of empty plastic containers which is configured like this, the empty plastic container P is supplied by a supply mechanism 2 with a constant interval maintained between the containers while they are upright in the rotation mechanism 3. The empty plastic container P is suctioned and retained on the turntable 12 on the rotation mechanism 3 and is made to rotate along the trajectory of the turntable 12.

[0030] The various electron beams are irradiated to a single empty plastic container P from a single electron irradiation part 19 on the electron beam irradiation mechanism 4 so that it is synchronized with this rotation and is then sterilized. For this empty plastic container P, the pinion gear 23 of the interval retaining mechanism 5 has the same shape as the empty plastic container P. As the gear 20 and the pinion gear 23 interlock and turn, the interval D between the surface of the empty plastic container P and the front end part 19A of the electron irradiation part 19 are always constant which makes it possible to make the electron beam irradiation dosage homogeneous.

[0031] As a result, the shape of the pinion gear 23 is fitted to the empty plastic container P so that the electron beams can be irradiated evenly to empty plastic containers P of any shape, be they round or angular.

[0032]

[Effect of the Invention] According to the working of the present invention, the empty plastic container is rotated by the rotation device. At the same time, an interval retaining mechanism is set in place which is used to retain at a constant the interval between (1) the electron beam

irradiation mechanism which carries out electron beam irradiation while this rotates and (2) the empty plastic container. As a result, the dosage of electron beams irradiated is kept uniform regardless of the sectional form of the empty plastic container. At the same time, any interval can be set between these and high-speed, low-dosage sterilization can be carried out in line.

### **[Brief Explanation of Figures]**

**[Figure 1]** A schematic plane view of the device 1 used for electron beam sterilization of empty plastic containers based on the embodiment of the present invention.

**[Figure 2]** Likewise; a sectional lateral view of the important parts of the rotation mechanism 3, the electron irradiation mechanism 4 and the interval retaining mechanism 5.

**[Figure 3]** Likewise; a plane view of the important parts of the interval retaining mechanism 5.

**[Figure 4]** Likewise, a plane view of the interval retaining function using the interval retaining mechanism 5

### **[Explanation of Notation]**

1...Device for electron beam sterilization of empty plastic containers (practical embodiment of the invention, Figure 1).

2...Supply mechanism

3...Rotation mechanism

4...Electron beam irradiation mechanism

5...Interval retaining mechanism

6...Ejection mechanism

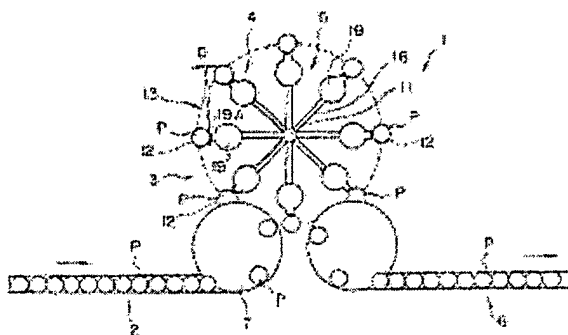
7...Star wheel

8...Motor

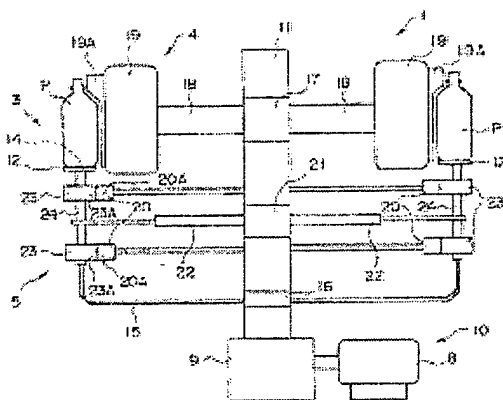
- 9...Reduction gear
- 10...Turntable drive part
- 11...Turntable drive shaft
- 12...Turntable for fixing empty plastic container
- 13...Rotation trajectory
- 14...Vacuum suctioning part
- 15...Vacuum hose
- 16...First rotary joint
- 17...Second rotary joint`
- 18...Radial arm
- 19...Electron beam irradiation part
- 19A...Front end part of electron beam irradiation part 19
- 20...Pair of upward and downward gears
- 20A...Gear part of gear 20
- 21...Third rotary joint
- 22...Air cylinder
- 23...Pair of upward and downward pinion gears
- 23A..Gear part of pinion gear 23
- 24...Coupling piece
- 25...Rotation arrow
- 26...Arrow indicating autorotation
- P...Empty plastic container
- D...Interval between surface of empty plastic container P and front end part 19A of electron

beam irradiation part 19 (Figure 4)

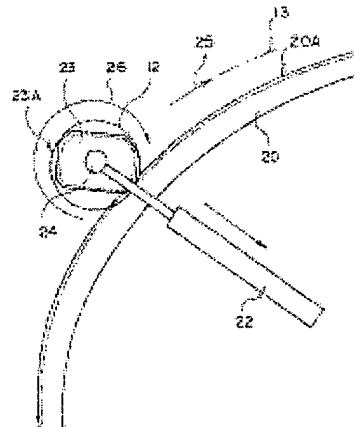
[Figure 1]



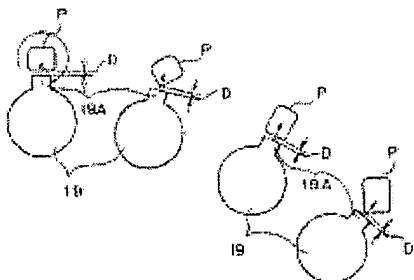
[Figure 2]



[Figure 3]



[Figure 4]



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